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Memoirs of the Department of Agriculture in India

THE MUSTARD SAWFLY

(*ATHALIA PROXIMA*, KLUG)

BY

H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S

Imperial Entomologist

AND

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Assistant to the Imperial Entomologist

AGRICULTURAL RESEARCH INSTITUTE, PUSA

PUBLISHED FOR

THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

BY

THACKER, SPINK & CO., CALCUTTA

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PREFACE.

THE insect described here, while not of great importance, is a minor pest to garden crops and is the sole common representative of its group in the plains of India. It is also typical of the class of insects found only in the cold weather, as opposed to those found breeding during the hot weather and rains and is therefore important, especially to students. I have thought that the full life history should be published; so far as possible this is done in Mr. Ghosh's own words, he being largely responsible for the section dealing with the life history, which was worked out by him under my supervision in the Pusa Insectary and by myself in the field.

PUSA,
Dated November 1907.

H. MAXWELL-LEFROY,
Imperial Entomologist.

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The genus *Athalia* is placed in Kirby's "List of Hymenoptera," Vol. I, at the head of sub-family XI, *Athaliinæ*, and includes a total of 17 species found in Europe, Asia, and Africa.

The only Indian species is *A. proxima*, Klug, which stands as follows in this list :—

Tenthredo (Allantus) *proxima*, Klug, Berl. Mag. VII, p. 130, n. 5 (1816).

Athalia tibialis, Cam. Trans. Ent. Soc. Lond., 1876, p. 460.

Expanse, al. 6-7 lin., long. corp. 3 lin.

Luteous, shining ; head, hinder half of thorax above, tarsi, hind tibiæ, upper side of the other tibiæ, and sheaths of saws black ; palpi pale testaceous ; lower edge of clypeus (occasionally) white. Wings smoky hyaline, with black nervures ; tegulæ luteous.

Male with the two basal joints of antennæ beneath and apex of clypeus, with the labrum, white ; clypeus very hairy, spurs pale.

Klug described this species as from Baltimore, but no other authority for the occurrence of an *Athalia* in America exists ; and after a careful examination of his description, I have no doubt that he had this common Indian species before him.

Hab. India.

a-g. (Types of *A. tibialis*). Barrackpur?—Sir J. Hearsey.

The description of Cameron's *A. tibialis* gives the locality as ? E. Indies ; Kunow's list of Tenthredinidæ in *Genera Insectorum* gives "India" and there appear to be no further references to this species.

Distribution.

This species has been found abundantly in the neighbourhood of Surat, Baroda, Ahmedabad and probably occurs throughout Gujrat ; at Bassein near Bombay ; at Poona in the Deccan. It has been observed at Nagpur and other places in the Central Provinces by the Entomological Assistant, Ratiram Khamparia ; it is known from Calcutta ; it has occurred every year in abundance at Pusa in Behar and apparently is common over Behar ; it has been observed in Cawnpore ; Mr. C. S. Misra, Assistant to the Entomologist, observed it in abundance on cruciferous crops in the Assam valley. In the Punjab it has been found at Lahore by Vishwa Nath Sahai, Entomological Assistant. It is apparently general in the plains over India north of a line drawn from Calcutta to Bombay ; it has as yet been only once reported from Madras, the Entomological Assistant of the Agricultural Department having reared it in the Shevaroys.

Food-Plants.

This pest was first found in the vegetable gardens near Surat, where it was destructive to cabbage. It has also been found to feed upon mustard, rape, sarson, torai and other cultivated varieties of *Brassica*, upon radish (*Raphanus sativus*) and halim

(*Lepidium sativum*). No wild food-plants have been found, but as its known food-plants are *Cruciferæ*, it is likely to be found on wild species of this natural order also.

Occurrence.

This insect has been under close observation at Pusa for three cold weathers and the intervening periods. It was first seen in the cold weather of 1904-05, feeding in some number upon rape, mustard and all varieties of *Brassica*, cultivated as field crops. The damage done was negligible, since the larvæ, though in fair number, were scattered and neither developed quickly nor increased rapidly in number. At the close of the cold weather it disappeared and no efforts availed to find it during the ensuing hot weather and rains. Early in the following cold weather (10th November 1905) as the young mustard crops came up, it was seen again, the imago being captured in the fields. The life history was then worked out, as described below, and a number were reared with the object of determining exactly its behaviour during the year. As is described below, Mr. Ghosh found that all the full-grown larvæ remained dormant throughout the hot weather and rains, then emerging within about three weeks. At the same time, the imagines were captured in the field, and on the 1st November larvæ were found on volunteer mustard.

We are justified in accepting the fact that this insect in Pusa is active from about October 15th to about March 15th, and then enters upon a period of repose as a resting larva. This applies to the great majority, but we are not in a position to say what happens to an imago hatching out, for instance, in March. Typically the species passes the dry hot weather and rains as a dormant larva.

In Surat and Baroda, the larvæ are found as early as June and normally appear in August and September. We have observed this in two seasons and we may assume that the

following paragraph in Indian Museum Notes refers to the same insect: (Indian Museum Notes, Vol. IV, No. 1, p. 32, 1896).

> "The following is taken from a report, dated 10th August 1894, by Mr. J. H. Middleton, Professor of Agriculture, Baroda College, forwarded by the Survey Commissioner and Director of Land Records and Agriculture, Bombay: -
>
> "Hymenoptera, Sawfly.—The larva of a sawfly attacks cabbage and most of the other plants of this family. Specimens were sent to the Museum, but without the *imago* they could not be named. I have attempted several times to rear the insect, but the grubs are very delicate and I have not yet succeeded.
>
> "The larva is greenish black and about $\frac{1}{2}$" long when full grown; it eats round the edges of the leaf and rapidly destroys seedlings.
>
> "This pest appears in September and passing through successive generations lasts for six months or more. It is especially bad in cloudy weather.
>
> "This insect is referred to in Volume III, No. 5, page 69, of these *Notes*."

The habits of the insect in this case are different from those observed elsewhere, and until further and far more extensive records are available, the behaviour of the pest cannot be predicted.

In Nagpur, in the Central Provinces, the insect has been captured or reared in November, December and January only, and in these months in considerable number. The same is true of Lahore, Cawnpore, and the Assam valley, and the evidence, so far as it is at present available, points to the insect having only a cold season activity in the greater part of India.

The pest has been officially reported in only one instance when it was sent in as being destructive in a garden in Dumraon. The destruction caused to field crops in Pusa has been negligible in each season.

In Surat, it is destructive to the cabbages grown by market gardeners for sale in the bazar, since the cabbages are unsightly and cannot so readily be sold. The cultivator there has a habit of collecting the larvæ in an earthen pot, but he is averse to destroying them, and, removing them to a little distance, he liberates them.

In Nagpur, the Entomological Assistant reports the insect as destructive to cabbage, radish and turnip grown as vegetable crops in gardens. This appears to be the only way in which it is a real pest, and experiments in Surat have shown that hand-picking into a vessel of water with a film of kerosene over is the simplest treatment, within the reach of a cultivator, but that spraying the plants with weak kerosene emulsion was the best treatment where it was possible.

In Pusa, plants were easily protected by dusting on a mixture of lime (20 pints) and kerosene (1 pint), which renders the plant distasteful. It has also been found that a trap crop of early mustard, sown so as to be well up when the main crop is being sown, is an excellent check, since the emerging adults lay their eggs in these plants ; the trap crop with its eggs and larvæ is removed when the main crop comes up. Should it be found that this insect is a serious pest, as is likely in some localities, we believe that such a crop will be the simplest check.

Habits —The habits of this insect in the insectary are dealt with below. In the field, the adults can be seen flying by day or sitting on the plants. The winged insect flies slowly and is sluggish by day ; it is more active at dusk and comes out then. Males and females occur in about equal numbers and the parthenogenesis, common in members of this family, does not occur in this species. The larvæ are semi-nocturnal, being active in the early morning and the evening ; in the middle of the day they hide in the soil or under shelter and come up before sunset. The leaves are eaten from the edge inwards and the larva displays none of the voracity common to Lepidopterous larvæ.

The full-grown larva makes two kinds of cocoons ; in some cases, it pupates between two leaves in a thin cocoon of white

silk ; this apparently takes place on the young crop or when a dormant larval period is not going to be entered upon. In other cases and always before æstivation, the cocoon is formed in the soil and is far more dense, with an outer covering of agglutinated soil.

Life History.—The life history of *Athalia proxima* in the insectary is passed partly on the food-plants, *viz.*, radish, mustard and other cruciferous plants and partly in the soil. Eggs are laid inside the tissue of the leaves. The grubs which hatch out of them, feed on the leaves until they are full-grown, when they leave the plants and enter the soil. There they form cocoons in which pupation takes place. After varying periods the sawflies come out and again lay eggs. The cycle is thus completed.

Athalia proxima has got only a winter season activity. It may have one or two or at the most three generations during the cold weather, and passes the rest of the year as a larva in the pupal cocoon under-ground in a resting condition ; in some cases the resting larva may pass over one whole winter and may not attain the adult stage till the second year, there being, therefore, no generation during the whole year. It turns into the pupa shortly before it emerges as an imago. Its activity, however, may not continue throughout the winter and it may enter upon the long rest in the middle of winter when it is yet very cold. Also it may commence active life after the long period of rest when the signs of approaching winter are hardly perceptible. Again, sawflies have been seen to emerge when summer weather has set in and after general resting has begun. But such cases are so solitary, that a fresh brood in warm temperature or summer is rarely possible. These points will be evident from an examination of the dates given below.

(1). Many grubs were collected on the 9th December 1905. These formed pupal cocoons by the 4th January 1906.

(2). More grubs were collected on 10th January 1906. These formed pupal cocoons by the 25th January 1906.

(3). Some grubs hatched from eggs between the 28th December 1905 and 7th January 1906. These formed pupal cocoons by 10th February 1906.

Out of them

One emerged as sawfly—4th March 1906.

Another ,, ,, 5th ,, ,,

A third ,, ,, 26th ,, ,,

The rest of the lot (3) and all of lots (1) and (2) continued to rest in the pupal cocoons in the larval state.

The first of them emerged as a sawfly on 29th September 1906.

76 emerged as sawflies between 9th October and 1st November 1906.

1 emerged as a sawfly on 9th March 1907.

2 ,, sawflies on 2nd November 1907.

Again.

(4). A lot of grubs, hatched from eggs, formed pupal cocoons by 10th December 1906. Of these only 1 emerged as a sawfly—2nd January 1907.

(5). Another lot formed pupal cocoons by 19th December 1906.

Of these 1 emerged as a sawfly—11th January 1907.

1 ,, ,, 15th ,, ,,

1 ,, ,, 16th ,, ,,

1 ,, ,, 26th ,, ,,

The rest of both the lots (4) and (5) continued their rest. No more sawflies emerged in the Insectary. But on the 27th March two larvæ were collected from a stray mustard plant. One died. The other formed the pupal cell on the date of collection and emerged as imago on the 12th April. The sawfly died on the 17th April, although it was well taken care of to see whether it could live through the summer.

The winter of 1905-06 was a very cold one. In such a year *Athalia proxima* may remain active from October till January. In a winter, however, which is not very cold (like that of 1906-07),

it may commence the long rest in December. Generally the grubs begin to rest in January and come out as sawflies in October, after a period of about 9 or 10 months.

One grub is seen to have formed the pupal cocoon in January 1906 ; it passed the winter of 1906-07 in the resting condition in the cocoon, and came out as an imago on the 9th March 1907, after a long resting period of about 14 months. It came out at a time when summer temperature was setting in and general resting was long ago begun. It is most probable that it passed over the winter of 1906-07 because it was not sufficiently cold ; but it came out as the adult fly later on in March, because it found the laboratory conditions not in favour of its continuing in the larval state till the following September or October. Also two grubs are seen to have formed the pupal cell about January 1906, and come out as imagines on 2nd November 1907 ; thus a grub may prolong its period of rest to about 21 or 22 months, and may include one whole winter in it, although winter is the time of its activity.

Athalia proxima has got no definite broods, adult flies as well as grubs in all stages being found at the same time. The reason of this is that the imagines do not come out at the same time after the long period of rest. The 76 flies which emerged between 9th October and 1st November 1906, came out in the following manner :—

Date of emergence.	October 9th.	October 10th.	October 11th.	October 12th.	October 14th.	October 15th.	October 16th.	October 18th.	October 19th.	October 20th.	October 21st.	October 22nd.	October 23rd.	October 24th.	October 25th.	October 26th.	October 29th.	October 30th.	October 31st.	November 1st.	Total.
Number of flies ...	7	5	4	2	2	3	5	3	1	2	8	4	6	9	6	2	2	3	1	1*	76

The life cycle is illustrated in the table below. There is no regularity in its periods which vary a great deal for members born at the same time. Some may rest ; while others hatched from eggs laid at the same time by the same fly may pass through one or even three generations. On a comparison of the table given below and the dates given above,

it will be evident that *Athalia proxima* can only have one or in some cases two or, at the most, three generations during the year. The shortest period of the cycle is about four weeks ; the longest period noticed is about 21 or 22 months. In the table the dates, when the pupal cocoons were formed, are noticed. As will be seen later on, the grubs turn into pupæ shortly before they emerge as flies ; the actual pupal stage is very short, occupying only about five or six days.

Eggs laid.	Eggs hatched.	Grubs formed pupal cocoons.	Sawflies emerged.	Duration in days.
10 X	14 X	27 X	9 XI	30
11 X	15 X	27 X	8 XI	28
14 X	18 X	29 X	9 XI	26
15 X	19 X	30 X	11 XI	27
17 X	21 X	4 XI	18 XI	32
15 XI	21 XI	10 XII	2 I	48
21 XI	28 XI	17 XII	11 I	51
26 XII	2 I	5 II	4 III	68
27 XII	4 I	10 II	Middle of October	About 9½ months.
31 XII	7 I	10 II	26 III	85
.....	.....	January 1906	9 III 07	About 15 months.
.....	.....	January 1906	2 XI 07	About 22 months.

Eggs.—Oviposition takes place only during the day time, from morning till some time before sunset. Eggs are laid inside the tissue of the margins of leaves. The female fly possesses a small black saw-like apparatus at the lower side of the abdominal end ; hence the name "sawfly." The margin of the leaf is slit open by means of this apparatus and the egg deposited inside. The female will be found sitting almost motionless on the margin of the leaf for less than a minute during which the saw works and the egg is thrust in. Many eggs may be laid in the same leaf, but only one at each place. The eggs are not visible, and there is no sign to show that they have been laid on any plant. Some sign appears later on as the time of hatching approaches. About a day before the grubs hatch out of the leaf tissue, small bulgings of the surface of the leaf are seen along its margin, the bulgings indicating where the eggs have been deposited. They are caused by the activity of the hatching young grubs.

Of the 76 sawflies which emerged between the 9th October and 1st November 1906, about 60 were given full opportunity of

coupling and laying eggs. The eggs could not be counted as they were hidden within the tissue of the leaf; but from them 902 grubs hatched out in all. If 30 of the above 60 sawflies are taken to be females, it is seen that each female lays about 30 eggs on the average.

The egg stage varies from about four to about seven or eight days according to the coldness of the time. The gradual lengthening of the period is shown below :—

Eggs laid.	Eggs hatched.	Duration in days.
10 X	14 X	4
15 X	19 X	4
23 X	28 X	5
4 XI	9 XI	5
15 XI	21 XI	6
21 XI	28 XI	7

Larva.—The young larva is a little less than 2 mm. long and cylindrical in shape. The head is black, round and flat in front; its axis is nearly at right angles to the body axis. The body shows no sign of segmentation and is minutely wrinkled transversely; it is hairless and so soft that it is liable to be pierced by the prickly hairs on radish and mustard leaves; when thus pierced a drop of a clear watery liquid exudes and collects at the place; the grub however does not mind these pricks. The colour is greenish grey. The thorax is thicker than the rest of the body. There are three pairs of thoracic legs and eight pairs of prolegs.

The larva turns darker as it grows; ultimately it becomes sooty black. After the 2nd moult a black stripe appears on each side of the dorsum. After the third moult one black stripe appears in the median line, and one more faint black stripe laterally near the base of the legs. The median stripe runs from the meso-thorax and not from near the head. As the surface of the body is minutely wrinkled, the stripes seem to be made up of a number of small points placed in rows; they become more and more prominent in succeeding instars. The full-grown larva measures about 16-17 mm. It does not differ materially from the young grub, but only undergoes the above changes.

Generally the larva moults six times before it pupates. Only one out of six larvæ, which were watched, passed through one more moult. Before each moult the larva rests for a few hours. The moult of the head is not cast separately like most caterpillars. In all the moults, the upper side of the head and of a part of the thoracic skin bursts longitudinally and the skin is cast off in not more than five minutes' time. Just after a moult the head is creamy white and shows a grey spot on each side, the body also looks greenish grey and not so dark as later on in the instar. Below are shown the number of moults and the length of the instars. The period of the last instar varies from about five days in the active season to generally about nine or ten months; in one case it was observed to extend to about 14 months and in two other cases to about 21 or 22 months. Some of the dates, given in the table, for the last moult at which the grub turns into the chrysalis are guessed, because they could not be observed in every case, as the moult was cast after varying periods.

Hatched.	1st moult.	2nd moult.	3rd moult.	4th moult.	5th moult.	6th moult.	7th moult.
Length about 2 m.m.	3 m.m.	5 m.m.	7 m.m.	10 m.m.	13 m.m.	16 m.m.	...
14 X	17 X	19 X	21 X	23 X	25 X	2 XI	...
15 X	18 X	20 X	22 X	24 X	26 X	1 XI	..
18 X	20 X	22 X	23 X	25 X	27 X	3 XI	...
19 X	22 X	24 X	25 X	27 X	29 X	4 XI	...
21 X	25 X	27 X	29 X	31 X	3 XI	10 XI	...
4 I	13 I	20 I	26 I	30 I	2 II	7 II	October.

As has been said above, the eggs are laid inside the tissue of the leaf. The young larvæ eat their way out and go on feeding on the leaves, producing in the beginning small holes in them. The grubs are slow-moving insects. As many eggs may be laid on the same plant, frequently many larvæ are seen to remain congregated on the same plant or on plants close to each other. If the plants are shaken, the grubs coil up and fall to the ground; they, however, climb up again after some time. They are not in the habit of injuring one another.

The larval stage of *Athalia proxima* may be very properly divided into two periods, *viz.*, (1) the active larval period which

lasts as long as the grub is active and eats food; and (2) the resting larval period when it rests in the pupal cocoon. The active larval period may vary from about 11 to about 37 days according to the coldness of the time. It is shown below:

Eggs hatched.	Grubs formed pupal cell.	Duration in days.
14 X	27 X	13
19 X	30 X	11
21 XI	10 XII.	19
28 XI	19 XII	21
4 I	10 II	37

The question of the resting larval period has been discussed in the beginning. In the active season it is about five days; one larva formed the pupal cell and began to rest on the 30th October, and it actually turned into the pupa on the 4th November.

Pupa.— When the grubs are full-grown and full-fed they leave the plants and enter the soil. There they form elongated oval seed-like cocoons or pupal cells and rest within them before pupation. The cocoon or the pupal cell is made of a very closely and thickly woven silken stuff secreted from the mouth. Earth seems to enter into its composition on the outside; externally it is earth-coloured; also the adhering earth cannot be completely washed off. Internally the colour is brown and glossy. The cocoon affords a good protection to the resting larva; it is perfectly water-proof; water cannot make its way into it even when it is kept submerged for a long time; also it is scarcely damaged unless squeezed between two tolerably hard bodies. As noticed above, many grubs may remain congregated on the same plant or on plants close to one another. Naturally when they enter the soil to build the pupal cocoons, many cocoons come to be formed at the same place. It is probably for this reason that frequently cocoons are found in a lump.

As described above, the larvæ do not turn into pupæ just after securing themselves in the pupal cells, but rest for widely varying periods. The actual pupal period is very short, being

about only five or six days. What was observed in the case of three grubs is given below :—

Building of the cocoon and commencement of rest.	Last larval moult and formation of pupa.	Emergence of the imago.
30 X	4 XI	10 XI
.....	13 XI	18 XI
January 1906.	5th March 1907.	9th March 1907.

The pupa is about 7 m.m. long. The antennæ, legs and the wings are folded on the ventrum. The colour of body, when the last larval moult is cast, is white with a greenish tinge and a black mid-dorsal line ; the eyes are blackish ; the appendages of the head, the legs and the wings are all white. Gradually the head becomes black, and then the thorax with the wings and legs ; the abdomen becomes yellow.

Imago.—The pupa casts off only a very thin, somewhat transparent pellicle and attains the adult stage. The adult sawfly does not or cannot emerge from the cocoon at once ; it bites a big hole at one extremity and comes out through it. It measures about 8 to 10 m.m. from the head to the end of the wings. Its antennæ, head, wings, tibiæ and tarsi are black, the rest of the body and its appendages being yellow.

The adult flies do not generally fly to a great distance ; but are seen to flit about from leaf to leaf or plant to plant. They are active only during the day time. With the setting of the sun their activity ceases, and they pass the night sitting motionless anywhere on the plants or on the ground, and hardly stir even when light is introduced. The females are a little bigger than the males. They couple end to end, and may pair and lay eggs on the day of emergence. In the Insectary they lived from two to six days.

Parasites.—The larvæ of *Athalia proxima* are liable to be parasitised by two species of Ichneumon flies. The peculiarity in the life of the parasites is that they also rest with the host for the greater part of the year, and it seems that they have got only one generation during the year. Some sawfly larvæ were

collected from the fields on 9th December 1905. Some more larvæ were collected on the 10th January 1906. A few of the larvæ were parasitised before these dates of collection. All of the above two lots formed pupal cells and began to rest by the 25th January 1906. Most of those which were not parasitised, came out as sawflies between the 29th September and 1st November 1906. Some parasites came out between 12th November and 8th December. Thus the complete cycle of the parasites took about a year. They come out some time after the sawflies, so that they may be sure of finding the sawfly larvæ in the fields. From their behaviour it appears that they claim only *Athalia proxima* as their host.

Explanation of Plate XX.

(1) Just hatched larva × 6 (Lateral aspect).
(2) Larva in the 3rd stage × 6. (Do.)
(3) Full-grown larva × 6. (Do.)
(4) Full-grown larva on the leaf × 3 (Dorsal view).
(5) Dorsal aspect of pupa (in the advanced stage) × 6.
(6) Ventral aspect of pupa (newly formed) × 6.
(7) The sawfly (the imago) × 6.
(8) A cluster of cocoons, the adhering earth being removed to some extent (each enlarged 4 times). One of the cocoons shows the mode of emergence of the imago.
(9) A single cocoon from which the adhering earth has been washed off × 4.
(10) A parasite × 4.

PLATE XII.

MUSTARD SAWFLY.

Engraved and Printed.

NOTICE.

THESE Memoirs, dealing with scientific subjects relating to Agriculture, will appear from time to time as material is available. They will be published in separate series, such as Chemistry, Botany, Entomology and the like. All contributions should be sent to the Editor, the Inspector-General of Agriculture, Nagpur, Central Provinces, India. Contributors will be given, free of charge, fifty copies of their contributions.

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